# CHAPTER 7

# SYSTEM SHUTDOWN AND CONFIRMATION OF CLEANUP

## 7-1. Introduction.

a. System shutdown should be considered when process monitoring indicates that either the remediation objectives have been met, or the system is determined to no longer be effective. System shutdown involves two primary components: closure sampling and analysis, which may need to be conducted over an extended period of time, and IAS mechanical system shutdown, disassembly and decommissioning. The closure sampling program should be conducted over a period of time to evaluate contaminant concentration rebounding, particularly at sites where NAPL was present. Post-closure monitoring is also advisable in many instances, as when NAPL remains after closure.

b. Shutdowns for mechanical or maintenance reasons are not considered here. They are almost exclusively dependent on the individual system components selected, and will accordingly vary in duration and severity. However, every system will require some shutdown time for maintenance and lubrication. The procedures for conducting these shutdowns will be specified in the O&M manual for the apparatus used.

## 7-2. Shutdown Strategy.

a. The shutdown strategy, including cleanup levels, sample schedules and methods, and a closure decision matrix, should be planned prior to starting up an IAS system. Figure 7-1 is a generic closure data evaluation matrix, incorporating a typical shutdown strategy. This strategy should be incorporated into the Work Plan, and should be approved or agreed to by the appropriate regulatory entities. The shutdown strategy may require revision, such as identifying different or additional sample collection locations, if the spatial distribution of contaminants in the soil or groundwater changes over the duration of the IAS system operation.

b. System shutdown will be guided by the regulatory standards applicable to the site contamination. These site specific standards typically include state or federal Maximum Contaminant Levels (MCLs), although in some cases, alternate cleanup goals can be negotiated based on specific potential local receptors and contaminant mobility. Typical parameters used to design IAS systems and support alternate cleanup goals include soil organic carbon content and hydraulic conductivity. An understanding of contaminant distribution, fate and transport can guide and minimize additional data acquisition requirements.

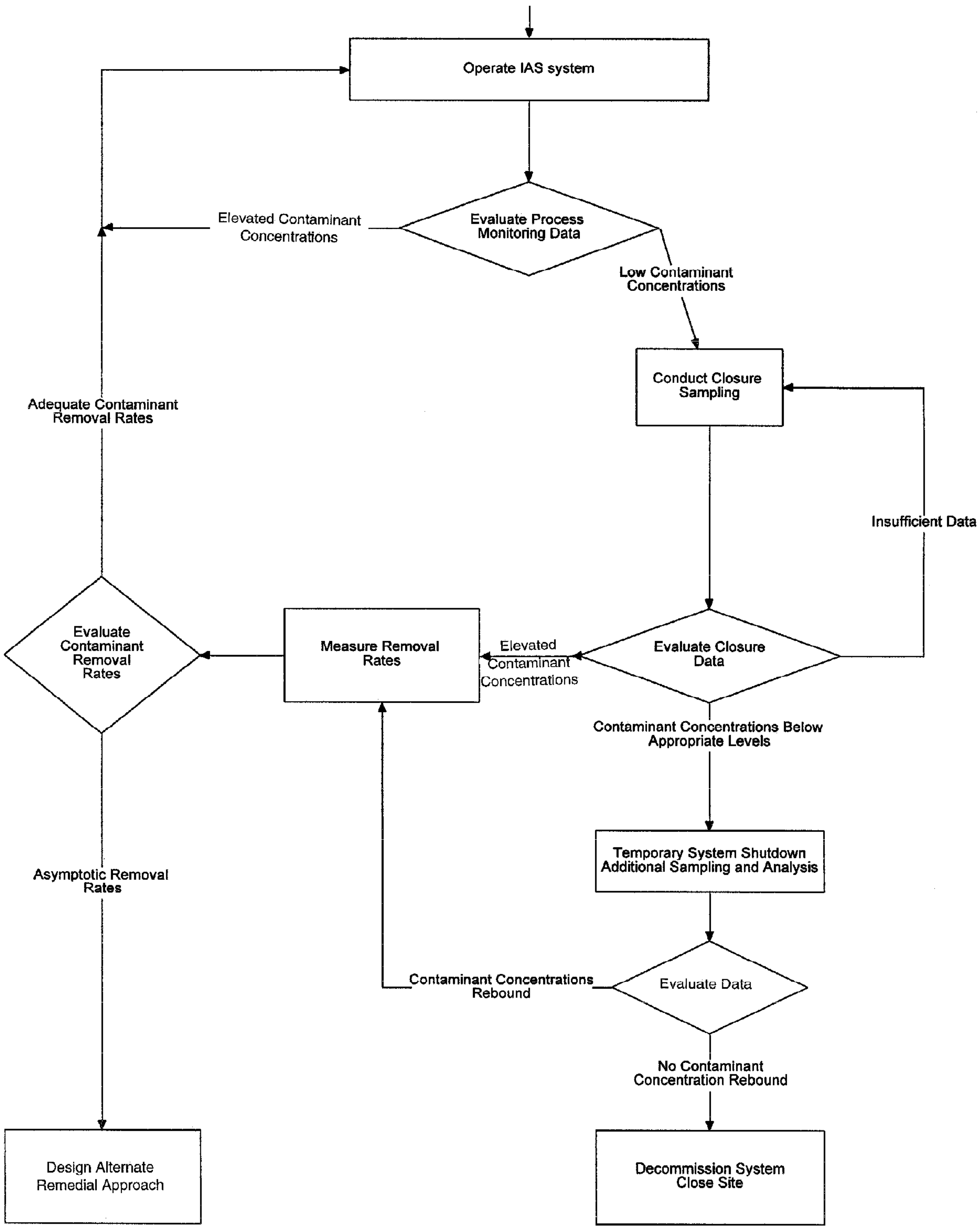


Figure 7-1. Closure data evaluation decision matrix

c. In most cases, actual sampling and laboratory analysis of the contaminated matrix (e.g., groundwater) is the only acceptable means of achieving closure approval. In some instances, secondary indicators such as exhaust gas and soil gas VOC concentrations, groundwater physical and (non-target) chemical parameters, and oxygen consumption rates have been proposed as acceptable indicators of contaminant concentrations. These secondary indicators, which typically are included in IAS process monitoring, determine the timing of matrix sampling to demonstrate achievement of regulatory objectives. Confirmational sampling should be conducted in accordance with standard SW 846 soil and groundwater sampling and analysis methods as summarized in the work plan (USEPA 1986).

d. Groundwater monitoring wells generally present an overly optimistic picture as to VOC and DO concentrations during, and for a while following, IAS. This is due to the tendency of sparged air to flow preferentially through a well*s filter pack and into the well itself (paragraph 3-3b(2)). It is therefore very important that sufficient time be allowed to elapse between IAS system shutdown and confirmation monitoring using conventional groundwater monitoring wells. Johnson et al. (1995) recommend a waiting period of greater than one month at wells that have been directly affected by IAS. Bass and Brown (1996), summarizing their IAS database findings, concluded that "When rebound occurred, it sometimes happened many months after sparge system shutdown." They reported that some sites "showed only moderate rebound 2 to 4 months following shutdown, but in some source area wells concentrations jumped by another order of magnitude or more within 7.5 to 16 months after shutdown."

e. With respect to the use of conventional groundwater monitoring wells, a minimum of 2 to 3 months should elapse between shutdown and confirmation monitoring. If some degree of rebound is still noted, sampling should be repeated subsequently. Applicable state and/or federal closure requirements may dictate the duration and frequency of confirmation sampling.

f. Wisconsin DNR (1995) recommends that when purging monitoring wells prior to sampling, the purge volume can be increased to remove water in and near the filter pack that may have been affected by preferential flow along the well. It is suggested that the purge volume required to draw in unaffected (i.e., more representative) groundwater may be considerable. Care must be taken to avoid aerating the well and stripping VOCs from the water in the process of purging it (paragraph 4-2).

g. If groundwater samples from small diameter driven probes are acceptable, such probes may be used to procure more representative samples, since they lack a filter pack capable of preferentially conducting airflow and their screen length is very short (Johnson et al. 1995; Wisconsin DNR 1995).

h. There are three possible outcomes from a successful closure sampling and analysis program to be considered in the shutdown strategy. The decisions to be made in each case will depend on the regulatory, cost, and technical constraints under which the system is being operated.

(1) Contaminant concentrations are and remain below applicable standards.

(2) Contaminant concentrations are below applicable standards; however, concentrations rebound following system shutdown.

(3) Contaminant concentrations are above applicable standards, yet the system has reached asymptotic removal rates.

i. Even if contaminant concentrations are above applicable standards, and the system continues to remove contaminant mass, it may still be possible to close the site, based on renegotiation with regulators after a reasonable period of operation. Such a strategy, if deemed acceptable, would employ natural attenuation as a follow-on to IAS.

7-3. Shutdown Guidance.

a. The simplest method of planning for shutdown and final sampling is to regularly monitor the site and track the data trends.

(1) There are three groups of parameters which may provide indications that the cleanup is nearing an end:

(a) Reduced VOC in the collection system. A gradual drop in VOC concentrations in the exhaust stream, usually from an SVE system, may indicate that contaminant levels in the soil have been depleted, at least in the ZOI. They may, however, merely indicate that mass transfer has become diffusion-limited.

(b) Reduced $CO_2$ or increased $O_2$ in the exhaust. Where bioremediation parameters are being tracked in the exhaust stream, a change in these concentrations may indicate that there is little material left to degrade. Performance of periodic in-situ respirometry tests, either in the vadose zone (Hinchee et al. 1992) or in the groundwater (paragraph 4-3d) may help support this trend.

(c) Reduced VOC in groundwater samples collected after the IAS system is shut off. Biodegradable compounds will not necessarily be completely degraded, at first, in which case they may act to solubilize additional organic material into the groundwater, with an attendant rise in VOC concentrations. When this concentration subsequently falls, it may signal that the ZOI may have been finally depleted of partial breakdown products, and that bioavailable constituents have, to a practical extent, been removed.

(2) When one or more of these conditions appear, it is most useful to reread the criteria for shutdown written into the approved work plan or operating permit. This should provide the guidance necessary for the final confirmation sampling. The criteria should also specify whether the system is to be shut off for confirmation sampling, as is usually the case.

(3) Some general guidance for typical systems is provided below, for subsurface and surface equipment. This guidance assumes that the system has attained its remediation targets and final shutdown is required.

b. Shutdown Guidance - Subsurface. ASTM D 5299 gives general requirements concerning well decommissioning; however, well decommissioning procedures are usually dependent on state requirements, and these requirements must be checked prior to beginning decommissioning.

(1) The most typical case requires that the well be pressure-grouted and the surface restored to its previous condition. This usually means that the top 0.6 to 0.9 meters (two to three feet) of casing are cut and pulled from the well; the well is bored and a cement/grout mixture is placed down the well using a tremie pipe to fill the bore to the surface. Any curb boxes or other protection for the wellhead are also removed, and the surface is restored to match the surrounding grade and surface finish.

(2) In some cases the casings must be pulled. Even if this is not required, a licensed driller may need to be contracted to decommission the well. The most common method is to mechanically pull the casing from the ground (for shallow wells) or drill out the casing for deeper installations.

c. Shutdown Guidance - Surface Equipment.

(1) The surface equipment is often configured in a package, and so the package is simply moved to storage or to another site. The surface piping and manifolds are removed and usually discarded using appropriate waste handling practices. Consideration should be given to removing and storing gauges, thermometers, and other measuring equipment, dependent on their condition and value. It is particularly important to properly decommission the system pumps and blowers. These units are often built with tight tolerances and can "freeze up" with rust or corrosion. Care should be taken to follow manufacturers' recommendations for both short down-time periods and extended system shutdowns.

(2) When the piping systems have been disassembled, it is helpful to blind-flange the piping connections to the package equipment, to prevent unnecessary exposure to the surroundings. It is also helpful to store the saved gauges and other measuring equipment with the package unit, so that they can be reused at the next site.